Overview of UPC Land Experiments Over Land Surfaces

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Summary
In view of future satellite missions such as SMOS and SMAP, the Remote Sensing Laboratory of the Universitat Politècnica de Catalunya (UPC) has undertaken in the last years some field experiments with the aim of improving the forward land emission model used in soil moisture retrieval algorithms. Since 2003, a series of experiments have been carried out using the L-band radiometer LAURA. Each of these experiments focused its attention on a different soil or vegetation parameter: soil type and moisture (MOUSE 2004), soil roughness (T-REX 2004/2006), vine canopy, and soil moisture (SMOS REFLEX 2003/2006), and topography (TuRTLE 2006). In the last months a GNSS-R sensor has been installed in a wheat field to test the potential applicability of this technique to soil moisture estimation.

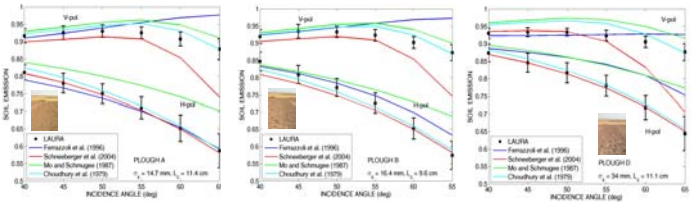
L-BAND RADIOMETRY: FIELD EXPERIMENTS USING THE LAURA RADIOMETER

1.T-REX 2004/2006: ROUGHNESS EFFECTS

- Location: Agramunt, Spain (41°43 N, 1°08 E, 362 m altitude)


Figures:

- Measured emissivity: Mean value (squares) and ±1 std. dev. error bar
- Solid lines represent simulated emissivities using different models and ground-truth data as input



2. MOUSE 2004: TEXTURE EFFECTS

- Location: JRC facilities, Ispra, Italy (45.48°N, 8.37°E, 213 m)



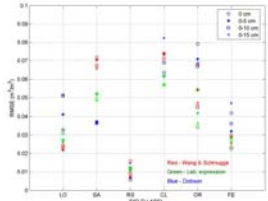
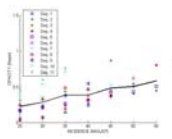
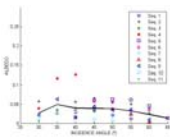
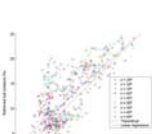


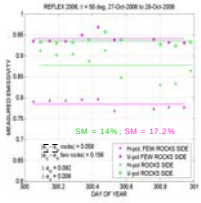
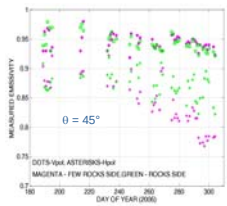
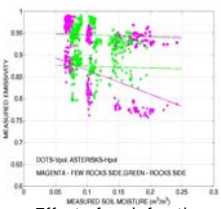
Figure: RMSE for every soil type as a function of the permittivity model and the depth of ground-truth soil moisture

3. SMOS REFLEX 2003/2006: MEASUREMENTS OVER VINEYARDS

- Location: Valencia Anchor Station, Spain (VAS, 39.6°N, 1.25°W, 780m). Site selected for SMOS CalVal activities

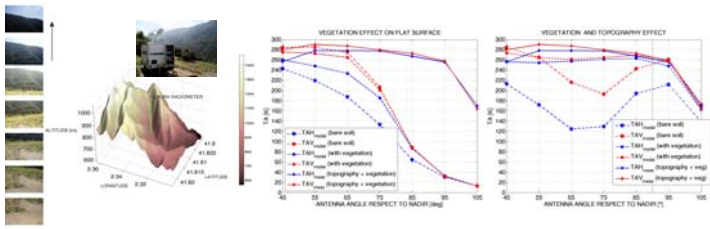

Opacity | Albedo | Soil moisture

Diurnal variation | Timeline variation | Effect of rock fraction

4. TuRTLE 2006: TOPOGRAPHY EFFECTS

- Location: Montseny, Barcelona, Spain (41.48° N, 2.19°E, 898 m)



- Antenna temperature simulations using a facet model which takes into account: HR-DEM and the land cover map of the site, polarization mixing due to surface tilting, and LAURA's antenna radiation pattern
- Four scenarios: (i) hypothetical scenario without vegetation and without topography, (ii) hypothetical scenario without topography but with the actual land cover map of the site, (iii) an hypothetical scenario without vegetation but with the DEM of the site, and (iv) the actual experiment site

Conclusions

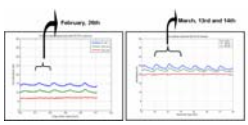
- Permittivity model impacts the accuracy of the SM retrieval: best model depends on soil type, RMSE from 2% to 7%
- Bare soil emission models do not fit the V-pol trend above 50-55°; better agreement for H-pol and Choudhury et al. (1979) and Schneeberger et al. (2004) models
- Simulations using a facet model agreed with measurements only when both topography and the land cover map were considered
- On dense vegetation fields (vines 9 kg/m²) albedo & opacity can be retrieved simultaneously with soil moisture, temperature and roughness, with RMSE soil moisture ~4%
- Up to 0.05 diurnal variation of the emissivity (~ 15K in brightness temperature), maximum reached at noon-afternoon if no rain
- V-pol emissivity has a mean value of 0.95 during the 4 months of experiment and seems independent of the rock fraction
- H-pol is more sensitive to changes in vines and soil moisture than V-pol if few rocks
- The trend of the emission as a function of ground-truth soil moisture is almost constant at the rocks side → radiometric measurements do not sense changes on the soil emission because of rocks → SM subestimation by the retrieval algorithms

IP-GPS-R FIELD EXPERIMENT

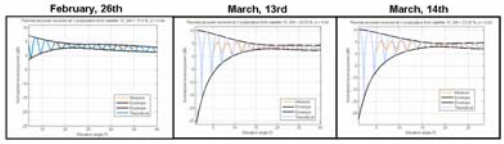
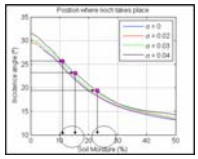
- Location: Palau d'Anglesola, Spain (41°39' N, 0 51' E)

- Instrument: Interference-Pattern GPS Reflectometer (IP-GPS-R)
  - 2 GPS receivers (one per pol.) connected to two passive antennas
  - 2 m height mast, antenna pointing 90º with respect to the vertical
- Measurements
  - GPS signal power obtained at V- and H- polarizations
  - Interference between the direct and the reflected signals
  - Automatic angular sweep due to the GPS satellites' passage

- An algorithm for bare soil scenarios has been developed through theoretical observations of the incidence angle value where the minimum power is received (notch): depends on the soil moisture content
- Then, real measurements are compared to theoretical approaches in order to achieve a good soil moisture retrieval.
- 3-4% soil moisture error due to the uncertainly in soil



February, 26th | March, 13rd | March, 14th

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